Frequently Asked Questions About the Development and Use of Background Concentrations at Superfund Sites: Part One, General Concepts

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Introduction

The U.S. EPA has addressed the role of background concentrations in the Superfund site assessment and remediation processes in a variety of guidance documents:

- *Risk Assessment Guidance for Superfund, Part A* establishes the role of background in risk assessment under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and provides guidance on sampling and statistical analysis to assess background (US EPA, 1989, referred to as "RAGS A");
- *Statistical Methods For Evaluating the Attainment of Cleanup Standards, Volume 3: Reference-Based Standards For Soils and Solid Media* provides robust statistical procedures for designing sampling programs and conducting statistical tests to determine whether contamination in remediated soils and solid media at Superfund sites attain site-specific background-based standards (US EPA, 1992c);
- *Role of Background in the CERCLA Cleanup Program* reiterates definitions established in RAGS A and sets current Superfund policy on background in risk assessment, risk management and risk communication (US EPA, 2002b, *Role of Background Guidance*);
- *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites* provides technical information on sample planning, collection methods, analyses and statistics; many recommendations are applicable to other non-dynamic media (US EPA, 2002a*, Soil Background Guidance*); and
- *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* provides sediment-specific recommendations, which take into consideration additional factors necessary for dynamic media, such as fate and transport (US EPA, 2005, *Sediment Remediation Guidance*).

To assist those seeking information on key components of EPA Superfund guidance on contaminant background, EPA's Office of Superfund Remediation and Technology Innovation (OSRTI) compiled excerpts and citations from relevant guidance documents, such as those described above, into this set of frequently asked questions (FAQs). EPA intends for this document to present an overview of the development and use of contaminant background information under CERCLA, including background dataset development and how such a dataset can be used in the different site assessment and remediation phases. These FAQs are part of OSRTI's continuing effort to improve national consistency in the Superfund program and to help ensure sound science is the basis of risk management decisions.

Scope

EPA does not intend to establish new guidance with this document; instead, its purpose is to summarize and elaborate on existing guidance and policy as well as to address specific issues common to the development and use of background under CERCLA. The document's scope is limited to established background policy and to scientific or statistical concerns regarding background data set development. This document does not include information to address broader Superfund programmatic risk assessment or risk management policies or decision-making.

Questions

1. What is natural background? What is anthropogenic background?

The Role of Background Guidance defines both anthropogenic and natural background (US EPA, 2002b):

> *Background* refers to constituents or locations that are not influenced by the releases from a site, and is usually described as naturally occurring or anthropogenic (US EPA, 1989; US EPA 1995a):
>
> 1) *Anthropogenic* – natural and human-made substances present in the environment as a result of human activities (not specifically related to the CERCLA release in question); and
> 2) *Naturally occurring* – substances present in the environment in forms that have not been influenced by human activity.

RAGS A states:

> Background can range from localized to ubiquitous. For example, pesticides -- most of which are not naturally occurring (anthropogenic) -- may be ubiquitous in certain areas (e.g., agricultural areas); salt runoff from roads during periods of snow may contribute high ubiquitous levels of sodium. Polycyclic aromatic hydrocarbons (PAHs) and lead are other examples of anthropogenic, ubiquitous chemicals, although these chemicals also may be present at naturally occurring levels in the environment due to natural sources (e.g., forest fires may be a source of PAHs, and lead is a natural component of soils in some areas).

Importantly, the definition of anthropogenic background is not restricted to a specific type of anthropogenic source. RAGS A explicitly describes examples of both localized and ubiquitous in terms of anthropogenic background: "Localized anthropogenic background is often caused by a point source such as a nearby factory. Ubiquitous anthropogenic background is often from nonpoint sources such as automobiles" (US EPA, 1989). Similarly, the definition of anthropogenic background EPA presents in *Role of Background Guidance* includes all contaminants present in the environment due to human activities but not attributable to a CERCLA release, which would include both diffuse and point sources (US EPA, 2002b).

2. When should background be measured? When is it not necessary to measure?

Generally, background concentrations should be measured whenever they may affect site decisions. Background may contribute to Hazard Ranking System (HRS) scoring, site delineation, conceptual site model (CSM) development, risk assessment, setting remediation levels, and remedy selection. Please refer to question three for a more detailed exploration of background's use within the Superfund Remedial Program.

When specifically considering whether to collect new background data or to rely on existing data sources (such as prior site investigations, peer-reviewed publications about the site or other survey data), please refer to the flow chart in figure 1, excerpted from the *Soil Background Guidance* [EPA 2002a]). This guidance specifically identifies circumstances under which background collection would not be necessary (US EPA, 2002a):

- "If the sample quantity, location, and quality of existing data can be used to characterize background chemical concentrations and compare them to site data, then additional samples may not be needed;"
- When "constituents are known and not expected to have been released to the environment from any source other than the site;" or if
- "Levels of background constituents may not exceed risk-based cleanup goals" and would therefore be irrelevant.

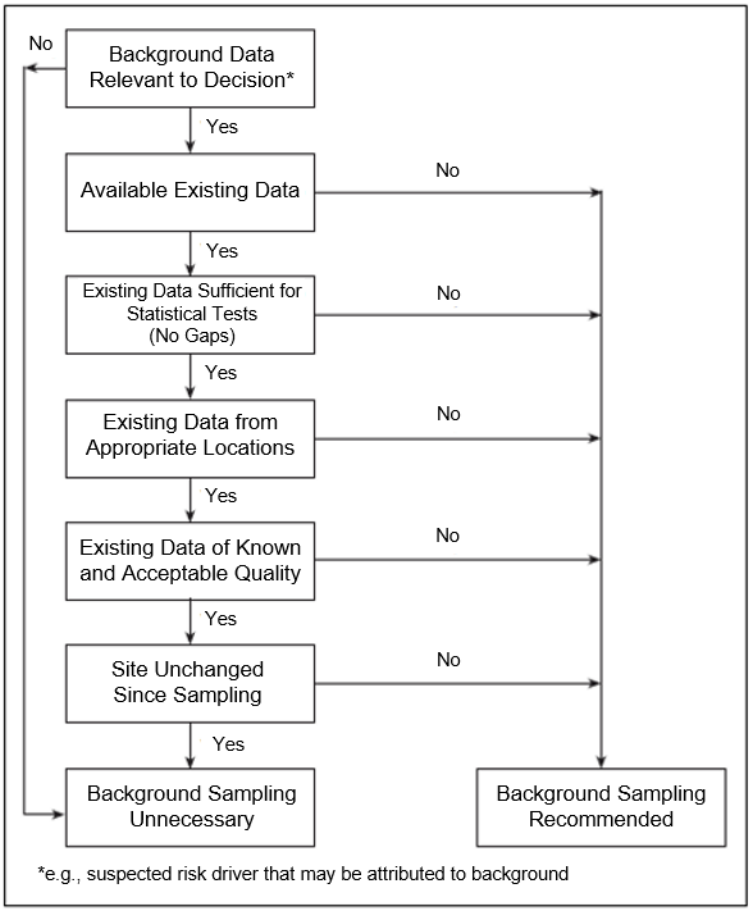

Figure 1: Determining the need for background sampling, excerpted from US EPA 2002a, figure 2.1

In the context of scoring releases for National Priorities List (NPL) purposes, a less rigorous standard may be applied. The *HRS Guidance Manual* notes the following for determining and using background for a site assessment or for HRS input:

> At some sites, it may not be possible to collect sample(s) to determine a background level. Certain circumstances may preclude background sampling (or use of available background sampling data) for the site. […] Under such circumstances, it may be necessary to establish the background level based on published data relevant to the site. Existing data from published reports should be evaluated to determine if background levels can be developed (US EPA, 1992b).

3. How is background incorporated into the Superfund process?

The use of background data under CERCLA depends on the context. Below are descriptions regarding the possible applications of background data in various elements of the Superfund Remedial process.

Hazard Ranking System Scoring: The HRS determination of background levels, usually by chemical analysis, is used to evaluate and document an observed release (Hazard Ranking System, Final Rule, 55 Fed. Reg. 51,532 [Dec. 14, 1990], codified at 40 C.F.R. pt. 300, app. A). Background levels can also be key in establishing contaminant attribution where multiple sources or contaminant contributors exist. In general, background levels are best supported by samples of representative ambient conditions, including the presence of anthropogenic and naturally occurring substances: "If the background concentration equals or exceeds the detection limit, a release is established if the sample measurement is at least three times the background concentration and attribution is established" (US EPA, 1992a). *Guidance for Performing Site Inspections Under CERCLA* states "[e]fforts requiring intensive background investigation or specialized techniques are normally part of the [Remedial Investigation and Feasibility Study] phase in the Superfund process after a site is placed on the NPL and becomes eligible for remedial funding" (US EPA, 1992a, *Site Inspections Guidance*).

Delineating Site Boundaries: Background concentrations may be used to determine the extent of contamination at a site and, ultimately, the boundaries for areas of investigation and cleanup (US EPA, 1988; US EPA, 2006b).[1]

Conceptual Site Models: Background may be a concern when identifying the extent of the release, understanding the risk levels, addressing the potential for recontamination of remediated areas, etc. (US EPA, 2006b).[1]

Risk Assessment: RAGS A provides general guidance for selecting chemicals, or constituents, of potential concern (COPCs) and considering background concentrations (US EPA, 1989). Both RAGS A and *Role of Background Guidance*:

> "…recommend a baseline risk assessment approach that retains all constituents that exceed risk-based screening concentrations. This approach involves addressing site-specific background issues at the end of the risk assessment, in the risk characterization. Specifically, the COPCs with high background concentrations should be discussed in the risk characterization. […] and if data are available, the contribution of background to site concentrations should be distinguished. COPCs that have both release-related and background-related sources should be included in the risk assessment. When concentrations of naturally occurring elements at a site exceed risk-based screening levels, that information should be discussed qualitatively in the risk characterization (US EPA, 2002b)."

Risk Management: *Role of Background Guidance* (US EPA, 2002b) presents a discussion on how background may be factored into risk management decisions:

[1] See section 3.2.4 of the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* and the Introduction and Chapter 4 of the *Guidance on Systematic Planning Using the Data Quality Objectives Process* (US EPA, 1988; US EPA 2006b).

> "Generally, under CERCLA, cleanup levels are not set at concentrations below natural background levels. Similarly, for anthropogenic contaminant concentrations, the CERCLA program normally does not set cleanup levels below anthropogenic background concentrations (US EPA, 1996; US EPA, 1997b; US EPA, 2000c). The reasons for this approach include cost-effectiveness, technical practicability, and the potential for recontamination of remediated areas by surrounding areas with elevated background concentrations. In cases where area-wide contamination may pose risks, but is beyond the authority provided under CERCLA, EPA may be able to help identify other programs or regulatory authorities that are able to address the sources of area-wide contamination, particularly anthropogenic (US EPA, 1996; US EPA, 1997b; US EPA, 2000c). In some cases, as part of a response to address CERCLA releases of hazardous substances, pollutants, and contaminants, EPA may also address some of the background contamination that is present on a site due to area-wide contamination."

CERCLA 104(a)(3)(A) provides a statutory limitation on removal and remedial responses to a release or threat of release of a naturally occurring substance in its unaltered form, or altered solely through naturally occurring processes or phenomena, from a location where it is naturally found. For example, in Boulder City, NV, actinolite (a form of asbestos) occurs naturally in outcrops and surface soils. While studies indicate that this naturally occurring asbestos poses a risk to local populations, this statutory limitation precludes EPA from using CERCLA to address these risks. Likewise, high concentrations of arsenic occur naturally in surface soils in some areas of the U.S. and would be subject to this limitation. CERCLA 104(a)(4) contains a rare exception to this limitation, under certain circumstances, during a public health or environmental emergency declaration.

Risk Communication: *Role of Background Guidance* addresses how background concentrations may affect risk communication:

> "EPA strives for transparency in decision-making (US EPA, 1995c) and encourages programs to better advise [sic] citizens about the environmental and public health risks they face (US EPA, 1997a). The presence of high background concentrations of COPCs may pose challenges for risk communication. […] In some cases, where area-wide contamination [background] may pose a risk, but is beyond the authority of the CERCLA program, communication of potential risks to the public may be most effective when coordinated with public health agencies (US EPA, 2002b)."

Cleanup Levels: When background levels are higher than risk-based cleanup levels or applicable or relevant and appropriate requirements (ARARs), background may be used to set remediation goals. *Role of Background Guidance* states that "[b]ackground information is important to risk managers because the CERCLA program, generally, does not clean up to concentrations below natural or anthropogenic background levels" (US EPA, 2002b). As noted in *Radiation Risk Assessment at CERCLA Sites: Q&A*:

> "When background levels exceed the remedial risk range, background levels may be selected as the cleanup levels. It should be noted that some ARARs specifically

address how to factor background into cleanup levels. For example, many radiation standards are increments above background levels, while the indoor radon standards under 40 CFR 192.12(b)(1) are inclusive of background (US EPA, 2014)."

Remedy Selection: Background may play a role in selecting remedies and setting performance standards, such as when recontamination is a concern. When non-site related contamination is upstream or upgradient from a remediated sediment site, the remediated area can be recontaminated over time to the upstream and/or upgradient background contaminant concentrations. In this scenario, a background concentration would serve as the basis of the "recontamination" value and, depending on the size or influence of the background sources, the background and recontamination value could be the same[2] (US EPA, 2017). For example, consider a site in a riverine environment, which is downstream from other contamination areas. If a cap was used to remediate the site, contaminated sediment deposition from upstream sources could contaminate the clean cap material. Over time, contaminated material from upstream will mix with or bury the clean material, and the incoming and bedded sediment contaminant concentrations will converge. In this case, it is reasonable to anticipate that future cap concentrations would be similar to the site's upstream and background areas. Such processes are not unique to riverine environments but could occur in any area (e.g., estuaries or reservoirs) where sediment or particulate transport processes occur.

4. How can you accurately capture anthropogenic background?

"Generally, the type of background substance (natural or anthropogenic) does not influence the statistical or technical method used to characterize background concentrations" (US EPA, 2002a). Yet, one key difference may be the selection of a background reference area to sample. For sites with suspected anthropogenic background chemicals, the background samples should be collected from areas likely to be affected by those same anthropogenic sources; for example, an urban site should be compared to nearby urban samples affected by the same diffuse background sources. For sites being evaluated under the HRS for possible placement on the NPL, "[b]ackground and release samples must be from the same medium (e.g., soil, water, tissue) and should be as similar as possible. Similar sampling methods should be used to obtain background and release samples (US EPA, 1992b)." *Soil Background Guidance* summarizes the issue as follows:

> The ideal background reference area would have the same distribution of concentrations of the chemicals of concern as those which would be expected on the site if the site had never been impacted. In most situations, this ideal reference area does not exist. If necessary, more than one reference area may be selected if the site exhibits a range of physical, chemical, geological, or biological variability. Background reference areas are normally selected from off-site areas, but are not limited to natural areas undisturbed by human activities. It may be difficult to find a suitable background reference area in an industrial complex. In some cases, a non-impacted onsite area may be suitable as a background reference area (US EPA, 2002a).

[2] See recommendations 2, 5, and 6 of the "Remediating Contaminated Sediment Sites" memo. (US EPA, 2017)

In dynamic environments, such as rivers and estuaries, sediment and water can transport in to and out of the site. Under those circumstances, it is important to determine whether background contaminants migrate into the site and, if so, to adequately sample areas contributing those contaminants. In this regard, the memo, "Remediating Contaminated Sediment Sites," states "[a]t large contaminated sediment sites, it may be important to evaluate background concentrations and the potential for recontamination" (US EPA, 2017). EPA (1995a) emphasizes that background sites "should be upstream, upgradient, or upwind of the site."

For additional information on media-specific sampling concerns, please refer to question five, immediately below.

5. Is the concept of "background," or its application, equivalent in different media?

The concept of background—a measurement of the chemical concentration present at/near a site without the influence of a CERCLA release—exists for all media of interest in the Superfund program. In general, background is used in similar ways: to determine if a release has occurred, to determine release-attributable risk and to set cleanup levels for the media affected by the release. However, there are some media-specific considerations for the concept and application of background:

- Sediments, surface water, air and groundwater are all dynamic media; there is potential for recontamination of remediated media from surrounding areas. From the S*oil Background Guidance:*

  > "Non-soil media are dynamic and influenced by upstream or upgradient sources. Such media—air, groundwater, surface water, and sediments—typically require additional analyses of release and transport, involve more complex spatial and temporal (e.g., seasonal) sampling strategies, and require different ways of combining and analyzing data (US EPA, 2002a)."

  The age of data (how long-ago samples were collected and analyzed) can matter more in dynamic systems as well.

- Background for sediment and surface water may fall under the other EPA program offices' authority and require greater communication between programs. Other regulatory programs' requirements, such as Total Maximum Daily Loads, National Pollutant Discharge Elimination System permits, combined sewer overflows and long-term control plans, may provide critical information for identifying and characterizing background sources. For a more detailed discussion of data collected under other EPA programs, see the memorandum "Promoting Water, Superfund and Enforcement Collaboration on Contaminated Sediments" (US EPA, 2015b).

- Background for vapor intrusion is generally used to distinguish whether vapor intrusion is occurring:

  > "[C]omparing contemporaneously measured concentrations and proportions of vapor-forming chemicals in indoor air, subsurface

media, and ambient air can be effective for [identifying and evaluating contributions from ambient sources], particularly when one (or more) of the analytes is known to be present only in the subsurface or in ambient air (US EPA, 2015a)."

- Tissue collection to determine background concentration in living organisms often requires unique considerations. Migratory patterns relevant to site fidelity, site-related contaminant uptake and metabolism should be considered. Also, site habitat and background area may affect contaminant exposure. Age structure of populations may affect contaminant levels; for example, in some fish, mercury levels are strongly correlated with age (US EPA, 2008).

Additional concerns, regarding sampling and identification of background reference areas, are discussed below, in question 6.

6. Generally, where and how should background data be collected?

Soil Background Guidance (US EPA, 2002a) states that soil background data should generally be collected off site, in a location that is as similar to on-site conditions as possible. At sites with anthropogenic background concerns, the background reference area should have a similar historical use pattern. Dynamic media have additional considerations, and it is important to consider the direction or dominant directions of media and contaminant transport to sample upgradient of the CERCLA release. For example, at sediment sites, hydrologically connected areas or sources with sediment and associated contaminants prone to transport are of particular importance for establishing background concentrations.

Table 1 includes excerpts from guidance providing information on how and where to sample for background concentrations in different media and for specific contaminants. Regardless of medium or contaminant, background sampling methods should be comparable to site samples; therefore, any media-specific sampling guidance or methods used for on-site sampling should also be applied for background sampling. In particular, the sampling type (discrete, composite, multi-increment sampling) should be the same for both background and site samples. Also, the sample depth, sample handling procedures, and analytical methods should be as similar as is practicable (US EPA, 1992a; US EPA, 2002a).[3]

A common challenge with comparing site data to background data is that on-site data sets are often spatially biased, while background data sets typically are not. Statistical methods exist that can reduce spatial bias influence. However, these methods are complex and a qualified statistician should be consulted.

[3] Chapters 3 and 4 of the *Site Inspections Guidance* (US EPA, 1992a) and sections 2.3 and 3.4 of *the Soil Background Guidance* (US EPA, 2002a).

Table 1: Medium- and Contaminant-Specific Considerations for Background Sampling

Medium or Contaminant	Considerations for Background Sampling
Air	"The determination of background locations for air monitoring requires constant and concurrent monitoring of factors such as wind direction." "Due to the inherent variability of air concentrations, background samples for air need to be relatively large" (US EPA, 1989). "Multiple background and target samples should always be considered. Background and observed release samples should be taken at the same time from approximately the same heights above the ground. Samples collected at great heights (e.g., rooftops) are not useful. Samples from very low heights are also not encouraged because field activities, particularly surface disturbance, may introduce artificial contamination. In general, dust or wipe samples are not recommended to establish a release to air" (US EPA, 1992a).
Benthic Toxicity	"A reference [often referred to as a background reference] sediment is typically collected near an area of concern (e.g., a disposal site) and is used to assess sediment conditions exclusive of material(s) of interest. Testing a reference sediment provides a site-specific basis for evaluating toxicity […] Comparisons of test sediments to multiple reference or control sediments representative of the physical characteristics of the test sediment (i.e., grain size, organic carbon) may be useful in these evaluations" (US EPA, 2000b).
Groundwater	"Background samples should be collected from nearby [upgradient] wells that are not expected to be influenced by the source of contamination or by other sites. If there are other sites or potential local sources of ground water contamination, additional background samples should be collected where possible to differentiate their contribution from that of the site under investigation" (US EPA, 1995b).
Radiation	"Background radiation levels at a specific site generally should be determined the same way background levels are determined for other contaminants: on a radionuclide and site-specific basis when the same constituents are found in on-site samples as well as in background samples. The levels of each constituent of potential concern at a site typically are compared with background levels of those constituents to determine whether site activities have resulted in elevated levels" (US EPA, 2014).

Sediment	"Background sediment samples should be from a location comparable to that of the release (e.g., fine sediments from quiescent zones)" (US EPA, 1995b). Tidal Systems: "One approach for background sampling is to collect outside of the zone of tidal influence (this can be gauged by the level of the highest tide). It is possible that tidal flow could pick up additional sources upstream. The effect of the tides on contaminant concentration should be considered. (Upstream concentrations would be highest during the rising tide and lowest at falling tide.) Consider collecting release and background samples at the same tidal level" (US EPA, 1995b). *Integrating Water and Waste Programs to Restore Watersheds* notes that "Numerous samples of surface water and sediment are generally collected directly downgradient of the site as well as upstream to evaluate the site's impact on the surface waterbody. In tidally-influenced [sic] sites, sampling should be conducted at different stages of the tidal cycle" (US EPA, 2007a). Rivers: Upstream samples are recommended. "The presence of multiple tributaries upstream with multiple potential sources would require collecting multiple background samples in each tributary to differentiate the potential contribution of contamination from off-site sources" (US EPA, 1995b). Ponds and Lakes: "For ponds and lakes, background samples may be collected near the inflow to the water body if it is not influenced by the source. A pond near the site may be selected for background sampling if it exhibits similar physical characteristics to the pond on site. For large ponds and lakes, background samples may be collected from the water body itself, but as far away as possible from the influence of the PPE (probable point of entry) and other potential sources" (US EPA, 1995b).
Soil	"Background samples should be collected from undisturbed areas if the site is located near areas filled in with soils from different sources. However, if the site is located in fill material, the background sample should come from the fill. Soil within drainage channels (e.g., overland migration segments) may be subject to influences unrelated to the site and generally should not be used as background" (US EPA, 1992a). "A background reference area should have the same physical, chemical, geological, and biological characteristics as the site being investigated, but has not been affected by activities on the site. […] The ideal background reference area would have the

	same distribution of concentrations of the chemicals of concern as those which would be expected on the site if the site had never been impacted. In most situations, this ideal reference area does not exist. If necessary, more than one reference area may be selected if the site exhibits a range of physical, chemical, geological, or biological variability. Background reference areas are normally selected from off-site areas, but are not limited to natural areas undisturbed by human activities. It may be difficult to find a suitable background reference area in an industrial complex. In some cases, a non-impacted onsite area may be suitable as a background reference area" (US EPA, 2002a).
Surface Water	"Numerous samples of surface water and sediment are generally collected directly downgradient of the site as well as upstream to evaluate the site's impact on the surface waterbody" (US EPA, 2007a).
Tissue	The quick reference fact sheet, "Establishing Background Levels," discusses technical aspects of bioaccumulation sampling in relation to background (US EPA, 1995b). Although fish are generally mobile organisms, background tissue concentrations may still be an important consideration in site investigations, typically within the risk assessments. *Sediment Assessment and Monitoring Sheet #1: Using Fish Tissue Data to Monitor Remedy Effectiveness* provides useful information on the collection of fish tissue samples at Superfund sites, including the design of sampling efforts for fish tissue background (US EPA, 2008).
Vapor Intrusion	For the vapor intrusion pathway, background is often not collected directly by going off site but instead from various unaffected locations on-site: "EPA recommends that site-specific data (e.g., sub-slab, indoor air and ambient air sampling data) be obtained [and evaluated to determine] whether indoor air concentrations arise from indoor or ambient air sources" (US EPA, 2015a). For evaluations of subsurface intrusion using the HRS, however, background should be documented by obtaining samples from similar structures which are not affected by the site or ambient air samples located upwind from suspected sources.

7. What background chemicals can we expect to find due to anthropogenic contamination? Natural occurrence?

It is not possible to create a comprehensive list of chemicals that should be screened for natural or anthropogenic background. However, several guidance documents refer to background chemicals that might be expected to occur naturally:

- "Some hazardous substances (e.g., lead, arsenic, copper) occur naturally in many areas" (US EPA, 1992a).
- RAGS A notes that "in general, comparison with naturally occurring levels is applicable only to inorganic chemicals, because the majority of organic chemicals found at Superfund sites are not naturally occurring" (US EPA, 1989).

Many chemicals found at Superfund sites are also present in the environment due to anthropogenic releases. RAGS A identifies PAHs, lead, chemicals used in pesticides and salt as potential anthropogenic compounds (US EPA, 1989). An EPA rural soil survey found detectable levels of dioxins, furans, PCBs and mercury at 27 of the survey's locations, far from any known or likely release (US EPA, 2007b).

Some chemicals are specifically identified as unlikely to be present at sites due to background sources. For example, *Vapor Intrusion Guidance* states that "when they are subsurface contaminants, volatile chemicals, such as cis-1,2-DCE, that are rarely or never present in indoor sources can be inferred to arise in indoor air via vapor intrusion 'without further explanation' (US EPA, 2015a)." Similarly, *Site Inspections Guidance* states that "some man-made hazardous substances (e.g., chlorinated organic solvents, short-lived radioactive substances) are not naturally occurring or ubiquitous and can only be attributed to a man-made source" (US EPA, 1992a).

8. What data sources may be appropriate, in lieu of collecting site-specific data?

Figure 1, above, taken from *Soil Background Guidance*, indicates that the following factors should be taken into account when evaluating the appropriateness of existing data in lieu of collecting additional data (US EPA, 2002a):

- Are the data adequate for statistical methods (i.e., can the data distribution be determined)?
- Are the data from appropriate locations (i.e., uninfluenced by site releases, sufficiently similar to site conditions, upgradient, spatially unbiased, etc.)?
- Are data of known and acceptable quality (i.e., were there clear data quality objectives [DQOs] for the data set's development, are the analytical quality assurance/quality control results included with the data set, do the data meet DQOs for the proposed use of background)?
- Have the site or background conditions changed since the data were collected?

The fact sheet "Establishing Background Levels" identified potential background data sources (US EPA, 1995b):

- "Background sample results from other nearby CERCLA site investigations
- Local surveys by EPA or other Federal or State agencies (e.g., U.S. Geological Survey (USGS), Soil Conservation Service (SCS))
- University studies
- Tables or databases with natural concentration ranges and averages in local or regional soils" (US EPA, 1992a).

The "Establishing Background Levels" fact sheet also notes that "[t]he use of background level data without sampling (e.g., published data) may be acceptable for SI [site inspection] or HRS scoring activities," but may *not* be sufficient for a remedial investigation (US EPA, 1995b). For a site inspection or HRS scoring, "[p]ublished data may be useful when selecting background sampling locations," or, if published data are used, "multiple sources of information help to support a comparison determination" (US EPA, 1992a). In either case, the DQOs should inform whether the published data are sufficient to support the remedial decision in question. An understanding of how and for what purpose the published data were collected will be critical for making this determination.

Although the *Vapor Intrusion Guidance* recommends use of a national background dataset for benchmarking, site-specific data is still expected:

> EPA does not recommend the use of generic values of historical background concentrations … to characterize current levels in any building, for purposes of supporting conclusions that indoor air concentrations are due to 'background' sources. Rather, EPA recommends that site-specific data (e.g., sub-slab, indoor air and ambient air sampling data) be obtained (US EPA, 2015a).

9. Should background be measured for non-site chemicals (not chemicals or constituents of potential concern)?

In general, the focus for non-site COPCs detected in background samples relates to communicating these risks to the public. RAGS A states that "anthropogenic background chemicals [that are not part of the site release] can be identified and considered separately during or at the end of the risk assessment … Omitting anthropogenic background chemicals from the risk assessment could result in the loss of important information for those potentially exposed" (US EPA, 1989). *Role of Background Guidance* further elaborates on this potential loss:

> In some cases where area-wide contamination may pose a risk, but is beyond the authority of the CERCLA program, communication of potential risks to the public may be most effective when coordinated with public health agencies. Examples of situations where Regions might coordinate risk communication with local, state or federal health officials are sites where widespread lead contamination or high levels of naturally occurring radiation have been found, but are not the subject of a CERCLA release into the environment. Public health agency officials may combine education and outreach efforts to inform residents about ways to reduce exposures and risks (US EPA, 2002b).

Role of Background Guidance goes on to note that risk characterization should include a qualitative discussion (US EPA, 2002b).

10. Is background static? How can changes in background concentrations be addressed?

In practice, background is usually treated as a static concept: a single number, or population of numbers, representing chemical concentrations in the environment that would be present in the CERCLA release's absence. *Soil Background Guidance* includes recognition that background concentrations can change over time, particularly for ubiquitous, anthropogenic compounds

released into waterways or air, which may change in frequency due to regulatory changes, permitting, or changes in technologies or industries near a site (US EPA, 2002a): "Non-soil media are dynamic and influenced by upstream or upgradient sources. Such media—air, groundwater, surface water, and sediments—typically require additional analyses of release and transport, involve more complex spatial and temporal sampling strategies, and require different ways of combining and analyzing data."

Expanding on this concept, *Sediment Remediation Guidance* states that "[a]t sediment sites, it is also frequently necessary to continue collecting background data from upstream or other reference areas away from the direct influence of the site. This can be especially important where there are uncertainties or potentially changing conditions in background areas, for example, where upstream urban storm water runoff or other possible continuing sources of contamination could impact a remedy" (US EPA, 2005).

Declines in background concentrations could occur at sites through natural processes, or if point and non-point sources of contaminants in the watershed or other contaminated areas are identified and addressed under various state and federal pollution abatement programs. Accurately predicting changes in contaminant concentrations over time resulting from natural processes and cleanups is highly uncertain, particularly over the decades that it may take for cleanups and contaminant declines to occur.

The "Remediating Contaminated Sediment Sites" memo recommends devoting substantial effort during the remedial investigation to establishing background contaminant concentrations at sediment sites because of background's potential use as cleanup levels as well as the potential for recontamination to determine contaminant levels that can be achieved through remedial action (US EPA, 2017). If it is anticipated that background concentrations will change over time, their use as a site-specific cleanup level should be revisited during the five-year review, as discussed in "Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid (US EPA, 2001a)?" For example, long-term monitoring plans could include sampling intended to establish background concentration trends, information that could be used to update the background-based cleanup level, if warranted. In this manner, potential background concentration changes over time can be appropriately accommodated.[4]

11. Can a reference location (for ecological risk assessment) be used to determine background?

The terms "reference" and "background" have been conflated in different guidance documents and are frequently used interchangeably. *Soil Background Guidance* defines "[a] background reference area [as] the area where background samples will be collected for comparison with the samples collected on the site" (US EPA, 2002a). Likewise, the 2000 *Benthic Toxicity Methods Manual* states: "[a] reference sediment is typically collected near an area of concern (e.g., a disposal site) and is used to assess sediment conditions exclusive of material(s) of interest (US EPA, 2000b)." Generally speaking, "reference" refers to ecological risk assessment reference

[4] See recommendation 6 of the "Remediating Contaminated Sediment Sites" memo for more details (US EPA, 2017).

areas, whereas "background" refers to chemical or radiological concentrations present in the environment due to natural sources or non-site related releases.

It may be possible to use a single reference or background location for multiple purposes. Yet, a common disconnect between a benthic risk reference location and a background location for understanding recontamination is that the reference location need not be hydrologically connected to the site but should be geochemically and biologically similar to the site. The background location should be located upstream or upgradient of the site, and similarities in morphology, geochemistry and biology are secondary considerations. Also, see related discussion in questions 4 and 6.

12. Is it acceptable to subtract background risk from your risk assessment?

No. *Role of Background Guidance* states that "COPCs that have both release-related and background-related sources should be included in the risk assessment (US EPA, 2002b)." RAGS A notes that "[if] background risk might be a concern, it should be calculated separately from site-related risk," and both *Role of Background Guidance* and RAGS A note that the risk characterization section should discuss COPC concentrations on site relative to background concentrations: "During risk characterization, chemical-specific toxicity information is compared against both measured contaminant exposure levels and those levels predicted through fate and transport modeling to determine whether current or future levels at or near the site are of potential concern" (US EPA, 1989).

As such, baseline human health risks are calculated based on the concentrations observed on site, or expected to be present on site, and these concentrations include background as well as site-related contamination.

13. How should background be reported in a risk assessment? How should data be presented?

As with other Superfund data collection efforts, a description of background should usually include the DQOs, a description of how background samples were collected and analyzed, from where they were collected, and the specific numerical results. RAGS Part D makes the following recommendation:

> Submit Supporting Information to substantiate the available Background Value shown for each chemical in Planning Table 2 and to enable verification of those values by EPA. The format of the summary should be determined by each region. The Supporting Information should provide relevant information for each chemical used to determine the background concentration, including (but not limited to) average, maximum, hypothesis testing of equality of the mean, and other information that may be required to fully describe the background selection process (US EPA, 2001c).

RAGS D provides further clarification in the discussion of Table 2, as referenced in the above quote, that the purpose is to include "information useful for data evaluation of chemicals and radionuclides detected," and that the report should include "[s]tatistical information about chemicals and radionuclides detected in each Medium [and the] detection limits of chemicals and radionuclides analyzed (US EPA, 2001c)."

14. How should elevated background concentrations outside of CERCLA authority be addressed?

Sometimes, background concentrations of contaminants may exceed risk thresholds. As noted in the *Role of Background Guidance*:

> In some cases where area-wide contamination may pose a risk, but is beyond the authority of the CERCLA program, communication of potential risks to the public may be most effective when coordinated with public health agencies. Examples of situations where Regions might coordinate risk communication with local, state or federal health officials are sites where widespread lead contamination or high levels of naturally occurring radiation have been found, but are not the subject of a CERCLA release into the environment. Public health agency officials may combine education and outreach efforts to inform residents about ways to reduce exposures and risks (US EPA, 2002b).

15. How should outliers be handled in background data sets?

"Outliers are measurements that are unusually larger or smaller than the remaining data. They are not representative of the sample population from which they were drawn, and they distort statistics if used in any calculations (US EPA, 2002a)." The soil background guidance goes on to say that outliers may be identified visually, using box plots or qq-plots, or by statistical tests such as Dixon's or Rosner's test (for normal data), or comparisons to the interquartile range (for non-normal data) (US EPA, 2002a).

Generally speaking, outliers should not be removed from a data set on the basis of a statistical test alone. Statistical tests may be used to identify potential outliers, but additional review is recommended to determine whether or not they are representative of the background population. Data Quality Assessment: Statistical Methods for Practitioners provides a high-level discussion of handling outliers:

> "Potential outliers may result from transcription errors, data-coding errors, or measurement system problems. However, outliers may also represent true extreme values of a distribution (for instance, hot spots) and indicate more variability in the population than was expected. Failure to remove true outliers or the removal of false outliers both lead to a distortion of estimates of population parameters and it is recommended that the QA Project Plan or Sampling and Analysis Plan be reviewed for anomalies that could account for the potential outlier.
>
> Statistical outlier tests give the analyst probabilistic evidence that an extreme value does not "fit" with the distribution of the remainder of the data and is therefore a statistical outlier. These tests should only be used to *identify* data points that require further investigation. The tests alone cannot determine whether a statistical outlier should be discarded or corrected within a data set. This decision should be based on judgmental or scientific grounds. (US EPA, 2006a)."

Superfund's Soil Background Guidance notes that some values identified as outliers may be due to non-normally distributed data:

> "An outlier might also exist when a sample is from the population of interest, but its distribution has more extreme values than the normal distribution. In this situation, the sample can be retained if a statistical approach is selected for which the outliers do not have undue impact (US EPA, 2002a)."

The guidance further explains that:

> "Data points that are flagged as outliers should be eliminated from the data set if field or laboratory records indicate that the sample location was not a reasonable reference area, or if there was a problem in collecting or analyzing the sample. However, background areas are not necessarily pristine areas. A data point should not be eliminated from the background data set simply because it is the highest value that was observed (US EPA, 2002a)."

References:

US EPA. 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*. OSWER 9355.3-01. EPA/540/G-89/004.

US EPA. 1989. *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)*. EPA/540/1-89/002

US EPA. 1992a. *Guidance for Performing Site Inspections under CERCLA*. OERR 9345.1-05. EPA/540-R-92-021.

US EPA. 1992b. *Hazard Ranking System Guidance Manual*. OSWER 9345.1-07. EPA 540-R-92-026.

US EPA. 1992c. *Statistical Methods For Evaluating The Attainment Of Cleanup Standards, Volume 3: Reference-Based Standards For Soils and Solid Media.* EPA 230-R-94-004.

US EPA. 1994. *Selecting and Using Reference Information in Superfund Ecological Risk Assessments*. OSWER 9345.0-101. EPA 540-F-94-050.

US EPA. 1995a. *Determination of Background Concentrations of Inorganics in Soils and Sediments at Hazardous Waste Sites*. EPA/540/S-96/500.

US EPA. 1995b. *Establishing Background Levels*. Quick Reference Fact Sheet. OSWER 9285.7-19FS. EPA 540/F-94/030.

US EPA. 1995c. *Risk Characterization Handbook*. Science Policy Council. EPA 100-B-00-002.

US EPA. 1996. *Soil Screening Guidance: User's Guide*. Office of Emergency and Remedial Response, Washington, DC. EPA/540-R-96/018, OSWER 9355.4-23.

US EPA. 1997a. *Cumulative Risk Assessment Guidance-Phase I Planning and Scoping*. Science Policy Council. https://www.epa.gov/sites/production/files/2015-01/documents/cumrisk2_0.pdf

US EPA. 1997b. *Rules of Thumb for Superfund Remedy Selection*. EPA 540-R-97-013, OSWER 9355.0-69.

US EPA. 2000a. *Guidance for Data Quality Assessment: Practical Methods for Data Analysis.* EPA QA/G-9, QA00 Version. EPA 600-R-96-084.

US EPA. 2000b. *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates*. EPA/600/R-99/064.

US EPA. 2000c. *Soil Screening Guidance for Radionuclides: User's Guide, Office of Radiation and Indoor Air*, OSWER 9355.4-16A.

US EPA. 2001a. *Comprehensive Five-Year Review Guidance*. OSWER 9355-7.03B-P. EPA 500-R-01-007.

US EPA. 2001b. *Early and Meaningful Community Involvement*. OSWER 9230-0-9.

US EPA, 2001c. *Risk Assessment Guidance for Superfund: Volume I Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments)*. OSWER 9285.7-47.

US EPA. 2002a. *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites*. OSWER 9285.7-41. EPA-540-R-01-003

US EPA. 2002b. *Role of Background in the CERCLA Cleanup Program*. OSWER 9285.6-07P

US EPA. 2005. *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*. OSWER 9355.0-85. EPA-540-R-05-012.

US EPA. 2006a. Data Quality Assessment: Statistical Methods for Practitioners. EPA QA/G-9S. EPA/240/B-06/003.

US EPA. 2006b. *Guidance on Systematic Planning Using the Data Quality Objectives Process*. EPA QA/G-4. EPA/240/B-06/001.

US EPA. 2007a. *Integrating Water and Waste Programs to Restore Watersheds: A Guide for Federal and State Project Managers*. EPA 540-K-07-001.

US EPA. 2007b. *Pilot Survey of Levels of Polychlorinated Dibenzo-p-dioxins, Polychlorinated Dibenzofurans, Polychlorinated Biphenyls, and Mercury in Rural Soils of the United States*. EPA/600/R-05/048F.

US EPA. 2008. *Sediment Assessment and Monitoring Sheet #1: Using Fish Tissue Data to Monitor Remedy Effectiveness*. OSWER 9200.1-77D.

US EPA. 2014. *Radiation Risk Assessment at CERCLA Sites: Q & A*. OSWER 9285.6-20.

US EPA. 2015a. *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*. OSWER 9200.2-154.

US EPA. 2015b. "Promoting Water, Superfund and Enforcement Collaboration on Contaminated Sediments." Memorandum from the Assistant Administrators of the Office of Water, Office of Solid Waste and Emergency Response, and Office of Enforcement and Compliance Assurance to the Regional Administrators.

US EPA. 2017. "Remediating Contaminated Sediment Sites - Clarification of Several Key Remedial Investigation/Feasibility Study and Risk Management Recommendations, and Updated Contaminated Sediment Technical Advisory Group Operating Procedures." OLEM 9200.1-130.